UNITED STATES MARINE CORPS
II MARINE EXPEDITIONARY FORCE (FORWARD)
UNIT 73923
FPO AE 09510-3923

UNCLASSIFIED UPON REMOVAL OF ENCLOSURE (3).

REDACTED DOCUMENT APPROVED FOR RELEASE.
SEE MARCENT FOIA 19.14

5830
SJA
31 AUG 2013

SECOND ENDORSEMENT on LtCol (b)(3) 10 USC 130(b), (b)(6) ltr 5830 CRUAS of 24 Jul 2013

From: Commander, II Marine Expeditionary Force (Forward)
To: Commander, U.S. Marine Corps Forces Central Command

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

1. (U/~~FOUO~~) I concur with the Commanding General, 2d Marine Aircraft Wing (Forward) and close the investigation.

2. (U/~~FOUO~~) The point of contact for this matter is Chief Warrant Officer 2 (b)(3) 10 USC 130(b), (b)(6) USMC. He can be reached at DSN NIPR at (b)(3) 10 USC 130(b), (b)(6) or NIPR email at (b)(3) 10 USC 130(b), (b)(6).

(b)(6)

B. J. FITZPATRICK
(b)(6)

Copy to:
CG, 2d MAW (Fwd)
DET OIC, VMU-1 (Fwd)

UNITED STATES MARINE CORPS
2D MARINE AIRCRAFT WING (FORWARD)
II MARINE EXPEDITIONARY FORCE (FORWARD)
UNIT 78005
FPO AE 09510-8005

IN REPLY REFER TO:
5830
CG

JUL 31 2013

FIRST ENDORSEMENT on LtCol (b)(3) 10 USC 130(b), (b)(6) ltr 5830 CRUAS of 24 Jul 13

From: Commanding General, 2d Marine Aircraft Wing (Forward)
To: Commander, U.S. Marine Corps Forces Central Command
Via: Commanding General, II Marine Expeditionary Force (Forward)

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

Ref: (a) JAGINST 5800.7F (JAGMAN)

1. Forwarded. In accordance with the reference, I concur with and approve the findings of fact, opinions, and recommendations made by the investigating officer.

2. I recommend that no further investigation is warranted and that this investigation be closed.

3. The original evidence from this investigation has been maintained by my Staff Judge Advocate (SJA). The point of contact for this matter is Major (b)(3) 10 USC 130(b), (b)(6), SJA, at DSN: (b)(3) 10 USC 130(b), (b)(6) or email: (b)(3) 10 USC 130(b), (b)(6).

(b)(6)

G. L. THOMAS

Copy to:
SJA, II MEF (FWD)
SJA, 2d MAW (FWD)
DET OIC, VMU-1 (FWD)
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UNITED STATES MARINE CORPS
2D MARINE AIRCRAFT WING (FORWARD)
II MARINE EXPEDITIONARY FORCE (FORWARD)
UNIT 78005
FPO AE 09510-8005

IN REPLY REFER TO:
5830
CRUAS
24 Jul 13

From: Lieutenant Colonel (b)(3) 10 USC 130(b), (b)(6) 3002 USMC
To: Commanding General, 2d Marine Aircraft Wing (Forward)

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

Ref: (a) JAGINST 5800.7F
(b) Naval Air Systems Command (NAVAIR) Base Contract N00019-11-C-0013 with Lockheed Martin
(c) NAVAIR Contract Amendment Number 129968
(d) COMNAVAIRSYSCOM msg 042015Z JUN 13 K-MAX Cargo Unmanned Aerial System (UAS) Category 3 Interim Flight Clearance for Operations in the Unmanned Configuration with UAS Systems Engaged in Restricted Airspace and Combat Zones
(e) (SECRET) 2d MAW (Fwd) Air Tasking Order (b)(7)f, 1.7(c) 5 Jun 13)
(f) Crew Personnel Records
(g) Flight Surgeon, VMA-311 ltr MED of [illegible] Jul 13 Medical Findings
(h) Aircraft Maintenance Records and Maintenance Summary Report
(i) CRUAS Complete Situation Report, Microsoft Excel Data File
(j) Engineering Analysis and Supporting Data Report to JAG Investigation Report #2013-06-05 A/C497 of 9 Jul 13
(k) Air to Ground Segment Interface Requirements Specification for K-MAX Cargo UAS Program of 2 Jan 13
(l) Cargo UAS Ground Control Station Operating Manual Main Operating Base of 1 Feb 13
(m) Kaman K-1200 Federal Aviation Administration (FAA) Approved Rotorcraft Flight Manual revised 23 Jun 05
(n) VMU-1 Standard Operating Procedures
(o) NAVIAR, Senior Engineer, Aeromechanics Division email of 22 Jul 13
(p) (SECRET) Joint Combat Assessment Team (Forward) (JCAT (Fwd)) Report: CRUAS-LT25 Event 06 0800D JUN 13
(q) Mishap [illegible] of 5 Jun 13
(r) Ground Control Station data files from 5 Jun 13
(s) NAVAIR, PMA-266 Cargo UAS/MQ-8B AV IPT Lead email of 18 Jul 13
(t) (SECRET//REL USA, ISAF, NATO) FOB (b)(7)f WO email of 19 Jul 13
(u) CLR-2, TSC, Recovery Personnel Interview of 2 Jul 13
(v) 2d MAW (Fwd) Deputy ALD email of 17 Jul 13
(w) Kaman CRUAS Tailwind Testing Results of 11 Jul 13
(x) (SECRET//REL USA, ISAF, NATO) 2d MAW (Fwd) METOC Officer email of 1 Jul 13
(y) (SECRET//REL USA, ISAF, NATO) Transverse Chat Logs from 5 Jun 13
(z) Engineer, Lockheed Martin email of 23 Jul 13

Encl: (1) 2d MAW (Fwd) CG ltr 5800 of 17 Jun 13, Command Investigation Appointment Letter
(2) Summary of Interviews
(3) Reference Compact Disc of 24 Jul 13

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

1. This investigation was conducted on Camp Leatherneck and Camp Bastion, Afghanistan over the period of 17 June to 24 July 2013 in accordance with reference (a) and enclosure (1). A thirty day extension to enclosure (1) was granted to ensure the results of the engineering review by Naval Air Systems Command (NAVAIR) could be completed and reviewed prior to the conclusion of the command investigation.

2. The investigating officer (IO) consulted with Lieutenant Commander (b)(3) 10 USC 130(b), (b)(6) (b)(3) 10 USC 130(b), (b)(6) is an officer that possesses knowledge and expertise relevant to aviation mishap investigations in accordance with reference (a).

<u>Findings of Fact</u>

1. On 5 June 2013, at approximately 2017, a Cargo Resupply Unmanned Aerial System (CRUAS), impacted the ground at the Helicopter Landing Zone (HLZ) at Forward Operating Base (FOB) (b)(7)f during a resupply mission.

a. The mishap aircraft is attached to Marine Unmanned Aerial Vehicle Squadron 1 (VMU-1), 2d Marine Aircraft Wing (Forward) (2d MAW (Fwd)).

b. The Bureau Number of the mishap aircraft is A-11497.

c. The mishap aircraft is a K-MAX (model K-1200) aerial vehicle manufactured by Kaman Aircraft and configured as an Unmanned Aerial System (UAS) through cooperation with Lockheed Martin and NAVAIR. The system is performing cargo missions in Afghanistan under contract between NAVAIR and Lockheed Martin, references (b) and (c).

d. The aircraft was operating in an authorized mode in a combat zone, reference (d).

e. The flight on 5 Jun 13 was an authorized flight on the 2d MAW (Fwd) Air Tasking Order (ATO), reference (e).

2. The duties and experience of the scheduled crew are outlined in the following subparagraphs. Crew information was discerned from personnel records, reference (f), and interviews, enclosure (2).

a. <u>Mission Commander (MC)</u>. The MC is responsible for all aspects of the mission to include planning, execution, completion, and documentation.

(1) Name: First Lieutenant (b)(3) 10 USC 130(b), (b)(6) 7220 USMC.

(2) Unit: 1stLt (b)(3) 10 USC 130(b), (b)(6) currently attached to VMU-1 from his parent command Marine Air Control Squadron 1 (MACS-1). He has been deployed in support of VMU-1 since April 2013.

(3) Qualifications and Experience: 1stLt (b)(3) 10 USC 130(b), (b)(6) qualified as Military Occupational Specialty (MOS) 7220 - Air Traffic Controller. His training pertinent to CRUAS includes his participation in a three day familiarization course for the K-MAX UAS prior to his deployment. As a mission commander for the CRUAS platform, 1stLt (b)(3) 10 USC 130(b), (b)(6) has supervised 104.3 hours of flight time, 78 sorties, and the delivery of 250,800 lbs of cargo.

b. Air Vehicle Operator (AVO). The AVO (pilot) is responsible for operating the UAS during the mission through the Ground Control Station (GCS).

(1) Name: (b)(6).

(2) Unit: Contractor for Lockheed Martin

(3) Qualifications and Experience: (b)(6) is a civilian helicopter pilot with instrument and commercial ratings. He has logged 2000 total rotary aircraft hours, 83.6 hours (including training) on the K-MAX UAS with 17 sorties. He has been with the CRUAS detachment since November 2012. (b)(6) completed the Lockheed Martin K-MAX Unmanned Aerial Vehicle (UAV) Course on 14 January 2013. He was approved as an AVO on 15 January 2013 and as a startup/shutdown pilot on 10 February 2013.

c. Aerial Observer (AO). The AO (co-pilot) serves as a secondary operator for the UAS through the GCS during the mission.

(1) Name: (b)(6).

(2) Unit: Contractor for Lockheed Martin

(3) Qualifications and Experience: (b)(6) is a civilian helicopter pilot and a flight instructor with instrument and commercial ratings. He has logged 1300 hours of manned rotary aircraft flight time. He did not have experience with cargo delivery before his experience with the CRUAS platform. He has logged 78.4 hours (including training) on the K-MAX UAS with 29 sorties. (b)(6) completed the Lockheed Martin K-MAX UAV Course on 14 May 2013 and approved as an AVO on 17 May 2013.

d. Startup/Shutdown (SU/SD) Pilot. The SU/SD pilot is responsible for starting and stopping the aircraft at the beginning and end of the mission and performing pre-flight and post-flight checks on the aircraft.

(1) Name: (b)(6).

(2) Unit: Contractor for Lockheed Martin

(3) Qualifications and Experience: (b)(6) is prior military CH-46 pilot with 2939 logged hours. He has been with the CRUAS detachment in Afghanistan since April 2013 and has logged 11 hours on the K-MAX platform. (b)(6) was approved as a SU/SD K-MAX pilot on 17 May 2013 and as a K-MAX pilot on 5 May 2013. His certificate for completing the Lockheed Martin course is not in his record.

e. Cargo Rigger. The cargo rigger is responsible for receiving, staging, and preparing the load for the mission.

(1) Name: Corporal (b)(3) 10 USC 130(b), (b)(6) 0451 USMC.

(2) Unit: Co (b)(3) 10 USC 130(b) (b)(6) temporarily assigned to VMU-1 from his parent unit, Combat Logistics Regiment 27. He has been deployed in support of VMU-1 since January 2013.

(3) Qualifications and Experience: Cpl (b)(3) 10 USC 130(b) (b)(6) a parachute rigger by MOS and qualified as a Joint Air Drop Inspector and a Jump Master. Cpl (b)(3) 10 USC 130(b) (b)(6) prepared and rigged cargo for the delivery of over 500 cargo loads since his time with the CRUAS detachment. Prior to working with the CRUAS detachment he has accumulated seven years of experience in his MOS and general cargo rigging experience in the Marine Corps.

f. Support Engineer. The support engineer is responsible for providing engineer expertise to the crew during and after the mission.

(1) Name: (b)(6)

(2) Unit: Contractor for Lockheed Martin.

(3) Qualifications and Experience: (b)(6) has been working the K-MAX program since 2008. He was the lead engineer for the first 2 years of the program, and then supported the program as the engineer assigned to Business Development. Other than a year and a half assigned to another UAV program at Lockheed, (b)(6) has been working in K-MAX engineering since 2008.

g. Aircraft Mechanic. The mechanic is responsible for the maintenance of the aircraft to ensure it is flight worthy.

(1) Name: (b)(6).

(2) Unit: Contractor for Swanson Group Aviation LLC.

(3) Qualifications and Experience: (b)(6) has 5 years of USMC experience as a CH-53 mechanic and 6 months experience as a mechanic on the L3 Vertex Army Helicopter in Afghanistan. He has been working on the K-MAX UAS since April 2013.

3. There were no injuries or deaths related to this mishap.

4. The crew was in good health, well rested, and there is no medical evidence of any medication or intoxicating substances that would have affected performance or judgment during the mission according to the medical evaluation in reference (g).

5. Aircraft history and maintenance.

a. The mishap aircraft had a total of 1573.3 hours prior to the flight, reference (h), including 700 mission hours in Operation ENDURING FREEDOM (OEF) reference (i).

b. There is no indication in the maintenance records of any maintenance issues related to the mishap, reference (i) and reference (j) paragraph 6.5.

c. Software version (b)(3) 10 USC 130(b) was loaded to the aircraft flight control computer on 18 February 2013 and software version (b)(3) 10 USC 130(b) was loaded to the mission management computer on 20 February 2013, reference (h). The latest software revisions are (b)(3) 10 USC 130(b) and (b)(3) 10 USC 130(b) respectively, reference (d).

6. Aircraft control and flight performance information.

a. Flight Control Systems. The aircraft can be controlled in both a manned and unmanned configuration. The manned configuration is used for test flights and preflight inspections in theater while the unmanned configuration is used for cargo delivery and retrograde missions. The unmanned system consists of hardware, flight computers, and a Main Operating Base (MOB) GCS. (b)(7)f. The (b)(7)f (b)(7)f References to the GCS in this investigation refer to the MOB GCS. The flight control system on board the aircraft also consists of a flight control computer (FCC) that contains the aircraft dynamics and flight laws and a mission management computer (MMC) that communicates with the GCS and the FCC. There is also a separate laptop on board the aircraft (b)(4), (b)(3) 10 USC 130

b. Aircraft Communications and Control. Communication with the aircraft control systems is performed through two data links. The Line of Sight (LOS) and Beyond Line of Sight (BLOS) communication links provide both the control signal from the GCS to the aircraft and telemetry data from the aircraft to the GCS. (b)(7)f, (b)(4), (b)(3) 10 USC 130 (b)(7)f, (b)(4), (b)(3) 10 USC 130 (b)(4), (b)(7)f reference (k) and reference (j) paragraph 6.2.3.

c. Flight modes. While operating in an unmanned configuration, the aircraft is controlled in differing flight modes. The following modes are pertinent in describing the aircraft states leading up to the mishap.

(1) Manual. In manual mode, the aircraft can be operated and maneuvered by the AVO. (b)(4), (b)(7)f (b)(4), (b)(7)f (b)(4), (b)(7)f the aircraft is meant to be operated primarily in an automated mode in the UAS configuration, references (l) and (z).

(2) Autonomous En Route. This is the nominal aircraft mode in which (b)(4), (b)(7)f is adjusted over the cargo delivery site to ensure the load is delivered at a precise location and that the aircraft is oriented into the wind, reference (l).

(3) Autonomous Commanded Load Delivery. This mode is entered into [redacted] (b)(4), (b)(7)f reference (1).

(4) Ingress Point (IP). [redacted] (b)(4), (b)(7)f reference (1) and enclosure (2).

d. Operating Limitations. References (d), (k), (l) and (m) describe the operating limitations of the aircraft.

(1) Maximum pitch attitude [redacted] (b)(4), (b)(3) 10 USC 130 reference (m) pg 2-4. The manual mode is limited [redacted] (b)(4), (b)(3) 10 USC 130 pitch attitude in the GCS MOB operating manual, reference (l) pg 14-16 paragraph 14.6.8.

(2) Maximum angle of bank [redacted] (b)(4), (b)(3) 10 USC 130 reference (m) pg 2-4. The GCS MOB operating manual also limits this angle [redacted] (b)(4), (b)(3) 10 USC 130 reference (l) pg 14-16 paragraph 14.6.8.

(3) Maximum hook load 6,000 lbs, reference (m) pg. 2-7. The VMU-1 SOP, reference (n) paragraph 3.a limits the load weight to [redacted] (b)(3) 10 USC 130.

(4) The flight clearance, reference (d) paragraph 3.A.8 and 3.B.C.B.2, states that during an HEZ the aircraft must be in wind conditions at a maximum of [redacted] (b)(3) 10 USC 130 of the aircraft.

(5) The flight clearance, reference (d) paragraph 3.B.1.C, states that during operations the maximum wind must be [redacted] (b)(3) 10 USC 130, (b)(7)f

(6) When carrying a load, the aircraft [redacted] (b)(7)f, (b)(3) 10 USC 130 reference (l) pg 14-24 paragraph 14.8.4.

(7) The aircraft must be in a [redacted] (b)(3) 10 USC 130, (b)(4), (b)(7)f release the cargo, reference (l) pg 14-18 paragraph 14.6.11.

(8) Communications (comm) Loss. If communications are lost the GCS and the MMC follow a comm loss procedure. Comm loss is defined as [redacted] (b)(7)f, (b)(3) 10 USC 130 reference (l).

(9) Warnings, Cautions and Alerts (WCA). The UAS is designed to send messages to the user through the GCS computer screen in the form of warnings, cautions and alerts. These are covered in reference (1) chapter 18. Pertinent CWAs for the mishap are: Load Weight Fail, Load Angle Fail, LOS Comm Fail, BLOS Comm Fail and Load Swing.

(a) Load Weight Fail. The load weight fail caution light will activate when the load cell has failed or the load weight is out of range (weight > 6500 lbs or (b)(3) 10 USC 130 weight change not active in auto delivery mode). Although the load weight caution is not configured to display during the auto delivery mode, it activates in several other modes when the load weight changes by more than (b)(3) 10 USC 130 Actions for load weight fail while at the FOB are to verify the load weight change is valid (cross check engine torque indicator, collective position indicator, and hook weight) and continue the mission using Manual Load Delivery as determined by Mission Commander. Or if the risk is too great, the AVO should abort and Return to Base (RTB), reference (1), page 18-6, table 18-2.

(b) Load Angle Fail. (b)(3) 10 USC 130, (b)(4) (b)(3) 10 USC 130, (b)(4) MC, reference (1), page 18-7, table 18-2.

(c) LOS and BLOS Comm Fail. These cautions are displayed when the LOS or BLOS data links are lost, reference (1), page 18-10 table 18-2.

(d) Load Swing. The GCS manual identifies load swing as an advisory so that crew members can take appropriate action. The manual states that if this advisory is active, there is the potential that load oscillation is occurring based on (b)(3) 10 USC 130, (b)(4), (b)(7)f (b)(3) 10 USC 130, (b)(4), (b)(7)f (b)(3) 10 USC 130, (b)(4), (b)(7)f reference (1), page 18-18 table 18-3.

(10) The GCS MCP operating manual notes non WCA conditions requiring operator action, reference (1) pg 18-21 paragraphs 18.2 and 18.2.1. It states that "UAV control commands are limited to (b)(3) 10 USC 130, (b)(4), (b)(7)f (b)(7)f. If during mission monitoring these limits are being exceeded, this is symptomatic of a control system difficulty. Possible causes are related to load oscillations... <u>If excessive aircraft attitude oscillations are</u> (b)(3) 10 USC 130, (b)(4), (b)(7)f *added*.

(11) Flight Clearance Warning. Several warnings are included in reference (d). The most pertinent warning states that "The K-MAX cargo UAS has not undergone complete hardware and software qualification testing. Loss of control of aircraft, loss of control link, or loss of payload control may occur."

(12) The NAVAIR study, reference (j), states that the aircraft has (b)(3) 10 USC 130, (b)(7)f However, this information is not resident in the documentation reviewed for this investigation.

(13) The NAVAIR study, reference (j), also notes that the control

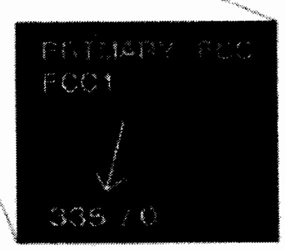
(b)(3) 10 USC 130, (b)(7)f

(14) Weathervane effect. Due to the aerodynamics of the aircraft and the large tail surface area with no tail rotor, the aircraft experiences a weathervane effect such that in the presence of wind, the aircraft naturally turns into the wind. Although the aircraft compensates for this effect to

(b)(3) 10 USC 130, (b)(7)f

(15) The wind indicator on the GCS GUI. The GCS manual, reference (l), states that the indicator for wind direction and speed is not accurate until the aircraft is (b)(3) 10 USC 130, (b)(7)f. The following figure depicts the wind indicator which displays the direction of the wind relative to the aircraft, the actual heading of the wind, and the wind speed.

(b)(3) 10 USC 130, (b)(4), (b)(7)f



7. Flight information and data. The flight originated at Camp Bastion with a destination of FOB (b)(7)f. The mission was to deliver approximately 2,000 lbs of Unitized Group Rations (UGR) cargo and return to Camp Bastion for a

second delivery. The mishap occurred during the delivery of the first load at FOB (b)(7)f. Note that all data recorded by the GCS is date stamped by the GCS computer. On 5 Jun during the mission, the GCS computer was running approximately 12 minutes fast when compared with other references (t-chat logs, recovery mission timeline, (b)(7)f laptop, etc.). In this report, time axes on graphs displaying GCS information are displayed using the GCS computer time stamp. All values noted and charts displayed are generated from the GCS data logs, reference (r)

a. Flight time, altitude and velocity - data derived from reference (r).

(1) The total flight time was approximately (b)(7)f and the total time of delivery was approximately (b)(7)f.

(2) The following graph depicts the altitude during the flight. The maximum altitude was approximately (b)(3) 10 USC 130.

Elevation (AGL - in feet)

(b)(7)f

(3) The following graph depicts the aircraft velocity during the flight. The maximum indicated airspeed (IAS) was 92 knots.

Aircraft Velocity (IAS - knots)

(b)(7)f

b. Weather data. Planned weather data was provided by several sources. Actual weather data at the cargo drop zone was not used, enclosure (2).

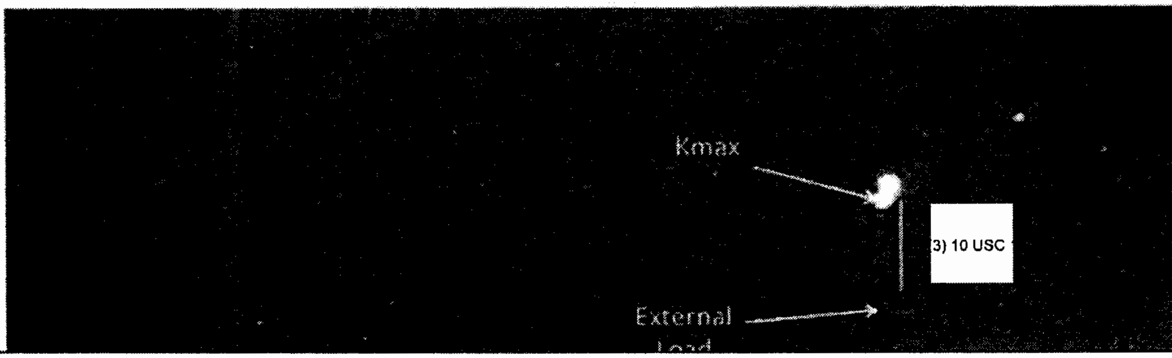
(1) Planned weather data. The planned weather data used by the Mission Commander was as follows:

Sky conditions: FEW 100 SCT 140
Winds: 280@13kts
Visibility: 7sm
Temp/DP: 38/10
Altimeter: 29.78
Flight Level Winds: 3000 - 285@17kts
6000 - 260@18kts
9000 - 320@18kts

(2) Actual weather data (extrapolated). The actual weather conditions at FOB (b)(7)f are not recorded because there is no weather station located there. Weather observations from witnesses at FOB (b)(7)f described the wind condition as light, reference (p). FOB (b)(7)f is the closest weather station, which reported the following data near the time of the incident. The following weather report was provided by the 2d MAW (Fwd) Meteorology and Oceanography (METOC) Officer after the incident:

At 2030 IVO (b)(7)f the weather was as follows:
Winds - from 140 deg at 3kt
Visibility - unrestricted
Skies - FEW at 18,000ft (agl)
Temp - 36C (97F)
Dew Poiont - 0C (32F)
Altimeter - 29.73 inHg
Pressure Altitude - [illegible]4[illegible]7
Density Altitude - [illegible]662
Sunset - 1915
Illumination - [illegible]9% (lowlight the entire night)
Moonrise - [illegible]46 the morning of the 6th
Lunar Lux - .0000

The NAVAIR engineering study, reference (j), attempts to calculate the actual value and direction of the wind from observations on the ground in the video of the crash, reference (q). Tracking the smoke pattern after impact and using the cargo line length (b)(3) 10 USC 130 as a reference, the wind is calculated at an average of 12 knots from the southeast - producing a tailwind on the aircraft. The engineering report calculates that the wind exceeded 10 knots. The following image from reference (j) and reference (q) shows the aircraft in the landing zone and the reference length used to determine the wind velocity. The camera is pointed generally to the west, reference (p).



(b)(7)f

c. Flight path and waypoint information. The flight followed the (b)(7)f path for delivering cargo at FOB (b)(7)f. This information is available in the GCS data logs, reference (r). The final hover point prior to automated cargo delivery was located at (b)(7)f feet AGL above the HLZ at FOB (b)(7)f.

d. (b)(7)f

(b)(7)f

(1) LOS data connectivity. The LOS data link had good connectivity through the mission (b)(7)f

(b)(7)f

reference (r).

(2) BLOS data connectivity. (b)(7)f

(b)(7)f

(b)(7)f, reference (j).

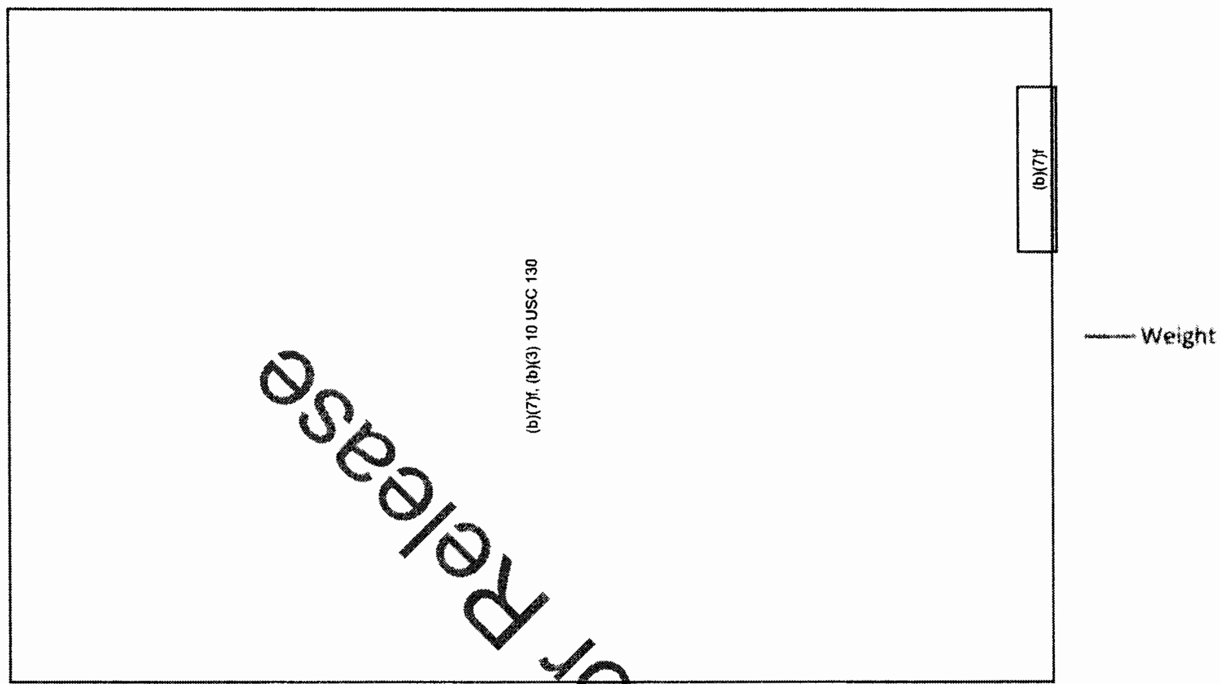
e. Flight conditions at destination leading to mishap. The mishap occurred due to pitch and load oscillations in the (b)(7)f of the flight during the automatic cargo delivery mode. The following table gives the timeline of the significant events. The timeline begins with aircraft takeoff and records pertinent events from the aircraft arrival at the ingress point through the final loss of data.

Time	Time to End	Event	Altitude (AGL - feet)	Heading (Degrees)
(b)(7)f	(b)(7)f	Airborne	(b)(7)f	(b)(7)f
		(b)(3) 10 USC 130, (b)(7)f		
		End of Data		

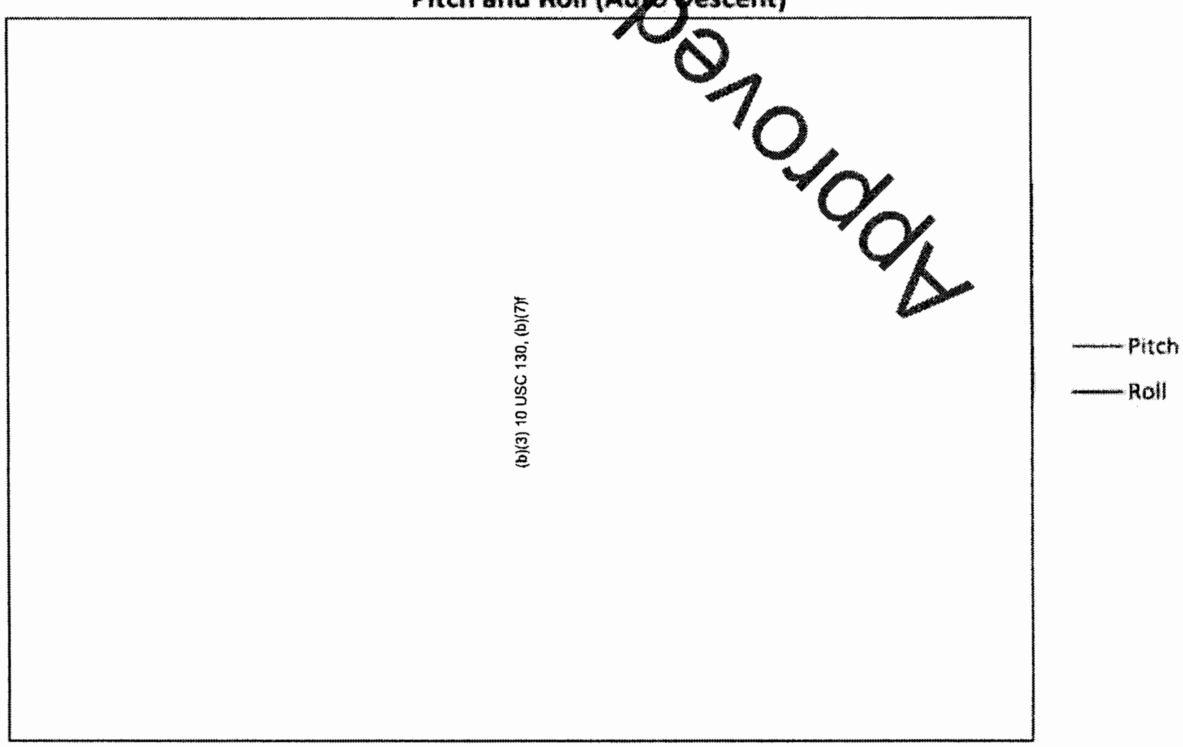
The following subparagraphs discuss different aspects of the instability that occurred in the last stage of flight. Note that the figures display a timeline that is not completely linear (b)(7)f the end of the flight.

(1) The figures on the next page depict the pitch, roll, and load weight of the aircraft during the auto cargo delivery mode. The instability in the (b)(7)f is clearly seen in the right portion of the figures. The aircraft entered a divergent control state in several differing aspects of the flight, reference (j). These instabilities are well represented by the two figures therefore additional data is not included here. The (b)(7)f of flight more clearly display the instability which can be seen in the following figures.

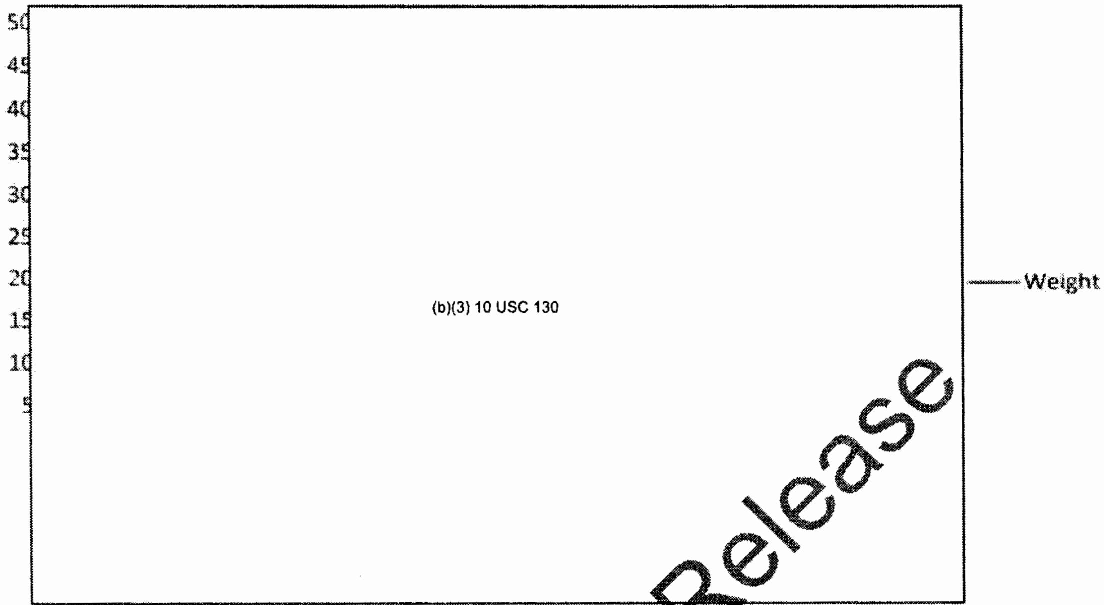
Load Weight (Auto Descent)



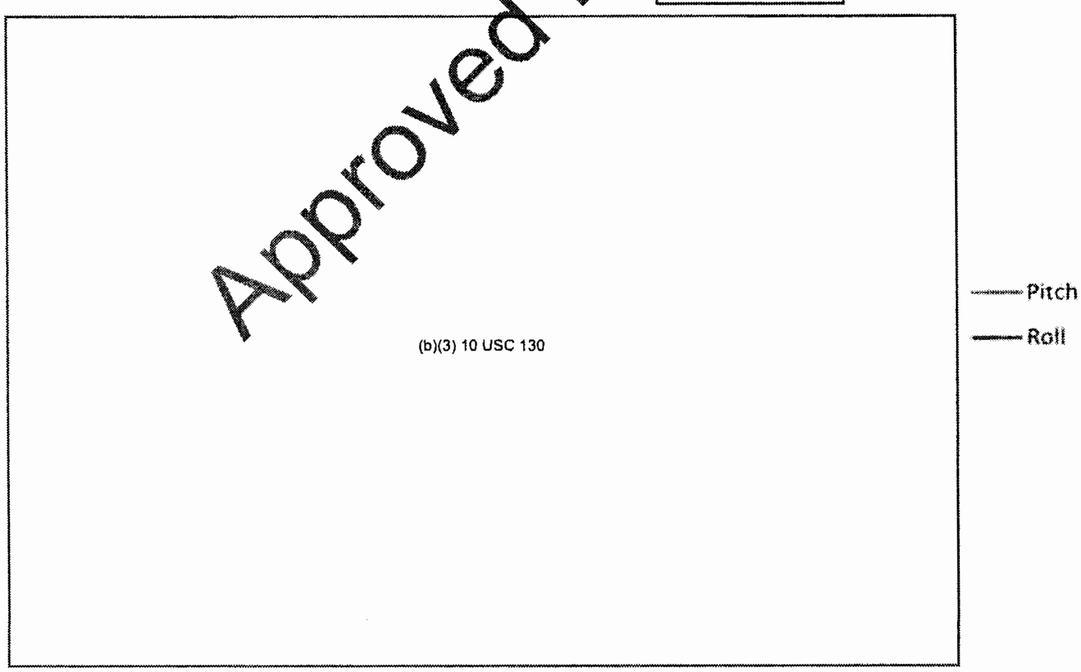
Pitch and Roll (Auto Descent)



Load Weight (Auto Descent - Last (b)(7)f



Pitch and Roll (Auto Descent (b)(7)f

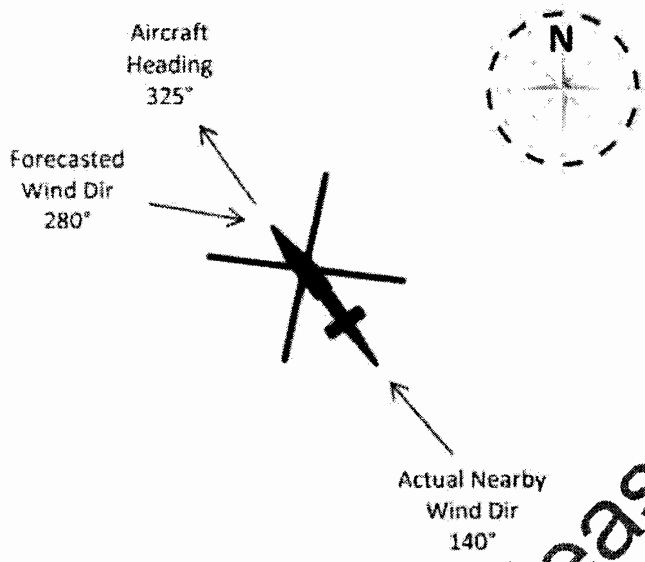


(2) Oscillating Pitch. GCS Graphical User Interface (GUI) displays the pitch through a standard turn and bank indicator. The oscillating pitch can be seen in the following screen shots of the GCS GUI during the flight. These screen shots were taken from reference (1). This divergent pitch condition eventually saturated the actuators causing the aircraft to lose control and impact the ground, reference (1).

(b)(3) 10 USC 130

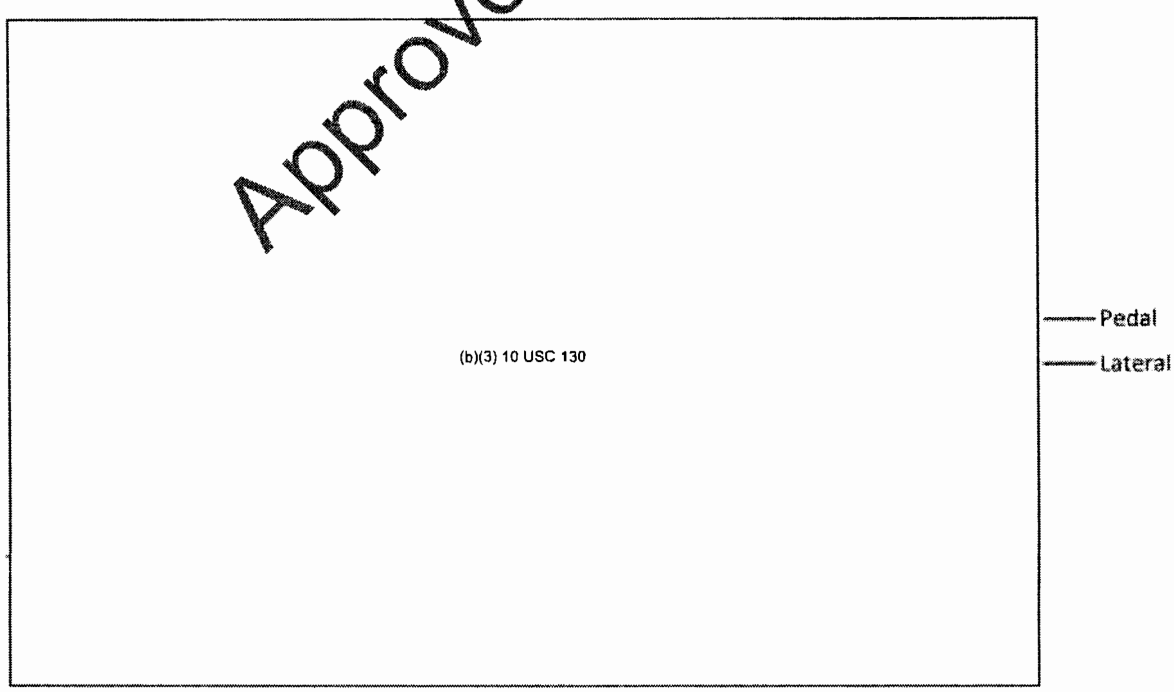
(3) Load weight. The load weight is displayed in the upper left portion of the GCS GUI instrument panel. A replay of the data using the GCS GUI clearly shows the significant oscillations in the load weight in the (b)(7)f (b)(7)f of the flight, reference (r). The load oscillation added energy to the oscillations and eventually the impact with the ground, reference (1).

(4) Influence of Wind. The crew used the planned weather to determine that the aircraft was in a headwind and the weathervane technique to allow the aircraft to reorient if this was not accurate, enclosure (2). The following figure depicts the aircraft heading, planned wind direction, and the observed wind at FOB (b)(7)f The actual wind was coming from a direction behind the aircraft based on weather observations near FOB (b)(7)f and observing the wind effect on smoke in the video of the mishap, reference (1).



Other indications that the wind was not as planned exist. There was a clear cross control situation as shown in the following figure (left pedal, right stick (cyclic)). This indicated, at a minimum, that a cross wind component was present. This component was not strong enough to invoke the weathervane effect on the aircraft, but becomes very close at (b)(3) 10 USC 130 rudder at the beginning of the descent, reference (r). This figure also shows a possible lull in the wind or shift to a tailwind condition as the pedal shifts right and the cyclic shifts left as noted in the NAVAIR study, reference (j).

Lateral Stick Position and Pedal (Auto Descent)



Another possible indication of the wind direction was noted as the aircraft approaches the ingress point, prior to cargo deliver. As the aircraft makes its approach, the aircraft experiences a slighter perturbation in its course. This was noted to the IO by the support engineer during a playback of the video. He suggested that this was indicative of a wind effect moving the aircraft slightly off course. This perturbation is consistent with a wind from the southeast. However, this may not be enough on its own to indicate the direction of the wind, but if noticed it might be enough to question the event. The following figure shows the slight deviation on the GCS GUI and the aircraft's left turn to move back to the path to the IP.

(b)(7) [redacted]

Additionally, the heading during the descent varied over a range of (b)(3) 10 USC 130, (b)(7)f [redacted] Data from three other flights showed variations of (b)(3) 10 USC 130, (b)(7)f [redacted] Time did not permit to study this further or analyze additional flights. When not in a crosswind or tailwind situation, the aircraft appears to maintain a very stable heading. One remaining note about the wind is that the wind indicator did not accurately depict the wind direction and speed. Multiple attempts were made by the IO to align the indicator data with observed wind when the aircraft was in excess of 30 knots of indicated airspeed with no success. The wind direction data varied too much to make any correlation to observed events.

(5) No weapons effects were observed by personnel at the FOB and the examination of the wreckage and aircraft components noted that weapons effects were highly unlikely to have caused the loss of the aircraft, JCAT study reference (s).

(6) The NAVAIR engineering study, reference (j) paragraph 6.2.2, found that all systems were operating and performing nominally and that there were no failures of systems in the recorded data recovered from the aircraft.

(7) Cargo. The method and manner of cargo rigging did not appear to contribute to the mishap. Pictures from the scene show the cargo was rigged tightly and was mostly intact after the incident, though the cargo and net were damaged, reference (p).

(8) The FCC software, version [redacted] that was loaded to the aircraft, vice the latest release, version [redacted] had no impact on the mishap, reference (o).

(9) There were no pertinent cautions, warnings, or alerts displayed during the automated delivery phase of the flight [redacted] reference (r).

8. Communication with the FOB. The Mission Commander had [redacted] of communication available to communicate with the FOB, specifically the [redacted] reference (t) and enclosure (2).

9. Crew experience and actions during the mission.

a. Only the AVO, AO, and MC were physically present at the control station during the mishap. The other members of the team were either in the office, on the grounds attending to their duties or had departed for the evening after their duties were complete.

b. Crew knowledge and experience.

(1) The personnel records of [redacted] and [redacted] indicated experience with varying wind conditions during K-MAX UAS training, reference (f).

(2) The crew indicated they knew the aircraft should be pointed into the wind during cargo delivery, enclosure (2).

(3) The crew indicated that they knew to put the aircraft into manual mode when aircraft limitations were exceeded, enclosure (2).

(4) The crew indicated knowledge of aircraft limitations (wind and pitch limitations specifically), enclosure (2).

c. Crew actions.

(1) The crew indicated that they saw the divergent conditions but did not attempt to regain control of the aircraft by putting it in manual control. GCS data files, reference (r), indicate no data directing control of the aircraft to manual mode. The crew stated that there was not enough time to attempt to regain control, enclosure (2).

(2) The crew did not request or receive updated weather info from observers on the ground at the FOB. The watch officer at FOB [redacted] stated that he did not provide updated weather information because he felt the weather conditions were normal, reference (t), and the mission commander stated he did not request this information from the FOB, enclosure (2).

(3) Observation of the aircraft state through the descent was not relayed to the crew, nor did the crew maintain communication with FOB observers such that it could be relayed, reference (t) and enclosure (2).

(4) The GCS data, reference (r), indicates that the crew issued no commands while in the manual hover at the cargo drop point to the rudder in order to adjust the heading of the aircraft. The operator did, however, wait for approximately (b)(7)f to allow the weathervaning to take effect and did issue a few small forward, aft, and left commands to maneuver the aircraft over the drop zone.

(5) There was an expectation by the crew that the aircraft would regain control if left to the control system software; however, this is not supported by the manuals or SOPs, enclosure (2).

10. Summary of causal factors.

a. There were no mechanical or system failures, references (h), (j) and (o).

b. The aircraft was operating outside of its design limitations.

(1) The pitch was outside the prescribed and aerodynamic limits of the aircraft, references (l) and (m).

(2) The aircraft was operating in a tailwind condition in a hover which was outside of its aerodynamic limits, references (j) and (w).

c. By exceeding the aircraft limitations, the control actuators became saturated resulting in uncontrolled flight and impact with the ground, reference (j).

d. The divergent oscillations were caused by atmospheric conditions, most likely a lull or a shift in the wind to a tail wind condition, a lack of control system software and appropriate state information to correct the resulting unstable flight in the automatic cargo delivery mode and no action by the crew to try and recover, reference (j), (r), and enclosure (2).

e. (b)(7)f (b)(6), (b)(7)f references (j), (r), and enclosure (2).

f. Inadequate documentation was available to document all flight states, references (d), (j), (l), and (n).

g. Although documentation did not describe the limitations of all flight states, non WCA conditions were documented and applied to the mishap conditions, references (j), (l), and (r).

h. The weathervane technique is not completely reliable for putting the aircraft into the wind in all cases. A crosswind component or tail wind may be present that does not allow the aircraft to reach more than a (b)(7)f in a manual hover mode and engage the weathervane technique to turn the aircraft into the wind, references (r) and (z).

i. Applying the non WCA procedures and orienting the aircraft into the wind dampens pitch and load oscillations, references (j), (l), and (w).

11. Additional information.

a. Aircraft Cost. The base contract lists each aircraft at $11,105,912.00 (included design, development, production, program and testing costs.) The original price of the aircraft not including development costs is between $8M and $9M, reference (s).

b. Cost to replace aircraft. Depending on what portions of the aircraft can be recovered, the estimated cost to replace the aircraft ranges between $5.7M and $6.9M, reference (s).

c. Additional damage. There were no additional collateral damages to any structures or property resulting from the mishap, other than the UGRs and the cargo net. The total cost of damage to the UGRs and cargo net was approximately $6,500, reference (u).

d. Aircraft damage. The aircraft impacted the ground tail first and a subsequent fire destroyed most of the tail boom, reference (p). The rotor blades impacted the ground and were broken into several pieces and fragments, reference (u). The (b)(7)f laptop was ejected from the aircraft through the left side of the cockpit window. The laptop was recovered and returned to NAVAIR in order to extract pertinent data from the incident. (b)(7)f (b)(7)f the flight data was recovered, reference (j).

e. The aircraft was recovered from FOB (b)(7)f by Combat Logistics Regiment 2 (CLR-2) with embedded personnel from Marine Wing Support Squadron 271 (MWSS-271) on 7 June 2013. There were no issues with the aircraft recovery. The main fuselage, the tail boom, and multiple disintegrated aircraft parts including rotor blade pieces, composite parts, and pieces of metal were recovered from the site and returned to Camp Bastion, reference (u).

f. The aircraft is being prepared for shipment pending disposition from NAVAIR. The tail boom and parts that are beyond economical repair are expected to be disposed of through Defense Logistics Agency - Disposition Services (DLA-DS), reference (v).

Opinions

1. The crew was qualified for the duties they were performing. FF 2.

2. The aircraft could not recover on its own based on the diverging conditions and its insufficient programming; it required human intervention. FF 10a, 10b, and 10d.

3. The mishap was preventable. Two major preventative measures could have been employed to prevent the mishap.

a. Aircraft Heading. Communication with personnel on the ground at (b)(7)f should have provided the local weather conditions and observation of the unstable pitch and load oscillations. An update of the wind direction and speed would have helped in the determination of the appropriate heading for the aircraft. FF 9c(2). Ensuring the heading was into the wind throughout the delivery would most likely have prevented the mishap. FF 10b(2). Additionally, ground personnel could have relayed the erratic behavior of the aircraft and alerted the MC that there was an issue. FF 9c(3). This warning along with the indication of instruments on the GCS control panel would provide ample evidence that there is an issue with the aircraft and lead the mission team to abort the delivery and regain control of the aircraft and load. FF 7e(4), 7e(1), 10g.

b. Return to Manual Control. When the aircraft began operating beyond its operating limits, the AVO, AO, or MC should have attempted to put the aircraft into manual mode and made adjustments to try to dampen the oscillations. FF 10g. The results of reference (w) make it questionable [redacted] however, the results do suggest that putting the aircraft back into the wind in such a situation would most likely have dampened the oscillations. FF 10i. The results are clear, however, that leaving the aircraft in an automated delivery mode in a divergent flight condition leads to an uncontrolled flight state and eventual impact with the ground. FF 10c.

4. [redacted] diverging conditions. FF 9c(5).

5. Of the two major indications of a problem - pitch and load weight oscillations - the crew did not identify the load weight oscillation as an issue during interviews or follow on conversations. Significant load weight oscillations should be another indicator that there is an issue. FF 7e(3).

6. The crew had indications that the aircraft was not pointed directly into the wind prior to the automated delivery; however, they did not manually point it into the wind. FF 7e(4).

7. There were enough communication assets available to request the weather at the FOB which may have led to the team to reorient the aircraft into the wind before descent. They should have requested weather information from the FOB. FF 9c(2).

8. The crew had enough time to put the aircraft into a manual hover mode once oscillations began, following the instructions in the GCS manual. FF 6b and 6d(10). If they would have put the aircraft into a manual hover mode they would likely have been able to dampen the oscillations. FF 10i. Even if the crew would have waited until the most extreme limits contained in the references, they would have had [redacted] command the aircraft into a manual hover. FF 7e (table). Time to transfer the data packet with the command to the aircraft, even with the [redacted] was sufficient to put the aircraft into a manual hover. FF 6b.

9. The following table catalogs crew actions performed and mitigating factors. They constitute a summary of pertinent findings of fact related to their responsibilities.

Crew Responsibilities

	Crew Actions/Inactions	Mitigating Factors
Put Aircraft into the Wind for Delivery	- Aircraft was not positioned into the wind at delivery – (j)(q)(r) - Crew did not request updated weather from the FOB – (2)(t) - No indication of attempt to change heading – (r) - Cross control condition in delivery supports that the aircraft was not turned into the wind – (j)(r)	- GCS indicators do not clearly depict wind direction and speed – (r) - Planned weather data was not accurate – (j) - Equipment for communication with ground observer was not available – (2)(t)
Regain Control of Aircraft in Divergent Situation	- Procedures to put the aircraft in a manual hover were not followed (no attempt to regain control of aircraft) –(2)(r)(l) - Did not fully consider load weight fluctuation in evaluation of aircraft state – (2)(r) - The GCS display indicated problems during delivery – (l)(r) (b)(3) 10 USC 130	- Data loss was significant - There was an expectation by the crew that the aircraft would regain control on its own – (j)(r) - Pertinent warnings, cautions, and alerts did not display in the auto delivery mode – (2) (r) - The Aircraft has not been fully tested – (j) - Manuals and SOP do not fully capture the conditions experienced – (d)(l)(n)

*letters denote references, numbers indicate enclosures

10. The (b)(7)f laptop that was ejected from the aircraft at impact could have inflicted serious injury or death if the flight had been manned. It also poses a threat to other instruments on board. FF 11d.

Recommendations

1. No further investigation from the command is warranted at this time.

2. Communications with the FOB and with the aircraft should be improved.

a. The CRUAS detachment should be equipped with communication devices that will allow direct communication with an observer on the ground when delivering cargo.

b. (b)(7)f

(b)(7)f

3. Training should be updated to include the results of this mishap. This scenario should be highlighted during training to ensure operators are prepared to respond to excessive pitch oscillations and load swings.

Training should ensure operators can recognize the symptoms, causes and results of oscillations and emphasize how to employ techniques to correct them. At a minimum, the crew should be trained to point the aircraft into the wind in an auto descent using all available indications and pitch and weight load should be thoroughly monitored through the delivery of cargo and return to the cargo waypoint.

4. Upgrade flight control systems.

a. Testing should be continued to gather more information on flight states and performance in a descent with a load.

b. The flight state model and control laws should be updated to include delivery mode test findings and conditions.

c. Warnings, cautions and alert software should be upgraded to ensure appropriate messages are displayed in the GCS GUI while in the auto delivery flight mode. The Load Weight Fail and Load Angle Fail cautions and the Load Swing alert should be active during auto cargo delivery. Load swing measurements should be transmitted to the GCS and displayed on the GUI so it can be monitored by the AVO during missions.

5. Update documentation.

a. GCS Manual, reference (l). The GCS manual should be updated to ensure the conditions that led to this mishap are addressed. Although, some information is included concerning the pitch oscillations, more information should be added with regard to load swings and the resulting change in load weight. More information should be added concerning the importance of load delivery into the wind, emphasizing that angles are appropriate. Additionally, information from the Kaman study, reference (w), should be added to ensure that the aircraft is not only put into a manual mode and [redacted] (b)(7)f but it should also state that the aircraft should be oriented into the wind to ensure oscillations are dampened.

b. Flight Clearance, reference (d). The flight clearance should be expanded by adding sections on auto cargo delivery. The limitations noted in the other modes should be clearly articulated in the new sections.

c. VMU SOP, reference (n). The VMU SOP should also be updated to include the auto cargo delivery mode and its limitations. Procedures should be added to instruct the MC, AVO, and/or AO how to recognize and respond to excessive pitch and load oscillations.

6. The wind and speed indicators do not display accurate data in the GCS GUI even when the aircraft's indicated airspeed exceeds 30 knots. The equipment and software required to calculate the wind speed and direction should be updated such that accurate local wind and speed can be displayed on the GCS GUI. This will add an additional indication of wind direction and speed that can be used by the operator to avoid operating in a cross or tail wind.

7. The weathervane technique should not be relied on solely to ensure the aircraft is oriented into the wind.

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

8. The control system software should be updated to ensure that appropriate stabilizing techniques are used in the auto delivery mode, as noted in the NAVAIR study, reference (j).

9. The (b)(7)f laptop should be secured to the aircraft in such a manner that future mishaps do not allow the potential of the laptop to become a hazard to pilots or on board systems.

10. The point of contact for this matter at this command is Lieutenant Colonel (b)(3) 10 USC 130(b), (b)(6) at DSN (b)(6) or at email: (b)(3) 10 USC 130(b), (b)(6)

(b)(3) 10 USC 130(b), (b)(6)

UNITED STATES MARINE CORPS
2D MARINE AIRCRAFT WING (FORWARD)
II MARINE EXPEDITIONARY FORCE (FORWARD)
UNIT 78005
FPO AE 09510-8005

IN REPLY REFER TO:
5800
LEGAL
17 JUN 2013

From: Commanding General, 2d Marine Aircraft Wing (Forward)
To: Lieutenant Colonel (b)(3) 10 USC 130(b), (b)(6) 3002 USMC

Subj: COMMAND INVESTIGATION INTO THE EVENTS SURROUNDING THE CRASH OF A CARGO RESUPPLY UNMANNED AERIAL SYSTEM, BUREAU NUMBER A-11497, ON OR ABOUT 5 JUNE 2013

Ref: (a) JAGINST 5800.7F
(b) MCO P4400.150E

1. This appoints you, per chapter II of reference (a), to inquire into the facts and circumstances surrounding the "Class A" aviation mishap of a Cargo Resupply Unmanned Aerial System, Bureau Number A-11497, assigned to Marine Unmanned Aerial Vehicle Squadron 1 on 5 June 2013 in Helmand Province, Afghanistan. This command investigation is convened in compliance with 10 U.S.C. § 2255 to investigate what is initially assessed to meet the threshold for a "Class A" aviation mishap.

2. Investigate the cause of the aviation mishap and any fault, neglect, or responsibility therefore, and recommend appropriate administrative and/or disciplinary action. Report your findings of fact, opinions, and recommendations in accordance with reference (a) no later than thirty days from the date of this appointment letter. If you cannot complete this investigation within the time limit, submit a written request for an extension before the due date. During the course of your investigation, you will comply with the requirements of the Privacy Act, Article 31 of the Uniform Code of Military Justice, the Health Insurance Portability and Accountability Act (HIPAA), and section 0201 of reference (a) when applicable. If you have not previously done so, read chapter II of reference (a) in its entirety before beginning your investigation.

3. The conduct of this investigation is your primary duty and will take precedence over your regular assigned duties until completed. During the course of your investigation, you may seek legal advice from Lieutenant Colonel (b)(3) 10 USC 130(b), (b)(6) 2d Marine Aircraft Wing (Forward) Staff Judge Advocate at DSN: (b)(6) or/at email: (b)(3) 10 USC 130(b), (b)(6)

(b)(6)

G. L. THOMAS

Copy to:
CG, 2d MAW (Fwd)
SJA, 2d MAW (Fwd)
Files

ENCLOSURE (1)

Summary of Interview on 2 Jul 13

1stLt (b)(3) 10 USC 130(b), (b)(6)

Mission Commander

1stLt (b)(3) 10 USC 130(b), (b)(6) was acting the Mission Commander for the CRUAS flight on 5 Jun. His MOS is 7220, Air Traffic Controller, and arrived at Camp Leatherneck with the deployment of VMU-1 near the beginning of May. He was an augment from MACS-1 and stated that he received two weeks of training on Shadow UAV platform and three days of training on the K-MAX UAS.

On the day of 5 Jun, he outlined the following general sequence of events.

- Checked the ATO for the evenings flights.
- Walked the lot with Cpl (b)(3) 10 USC 130(b), (b)(6)
- Performed the 1830 mission brief.
- Briefed the weather from several sources.
- (b)(7)f was the scheduled launch time.
- Coordinated with FOB
- Checked plan with AVO, ensures in accordance with DASC
- a/c started after communication with tower
- checklist was checked with the pilot
- Performed power assurance tests and load tests, load was at ~2k lbs
- Mentioned that communication was over (b)(7)f
- Everything up until the end was business as normal.
- Once they neared (b)(7)f (b)(7)f
- Didn't see pitch oscillations at first
- Saw a/c forward and down on the map, not where it was supposed to be
- Saw look on the AO's face and knew something was wrong
- The AO recommended that the MC call the JTAC at (b)(7)f
- Called JTAC but before connection (b)(7)f stating a/c was down came in
- Spoke to JTAC about injury to personnel and information about the mishap
- Once they identified that it was a mishap, they followed the mishap plan, some key elements are as follows:
  - Hands off controllers
  - Contacted ODO at VMU
  - Captured applicable data
  - Went to medical

Nothing else noted as odd or out of the ordinary with the a/c or sequence of events (other than the mishap)

They had had anomalies with this a/c before, had some pitch oscillations and non-response to control inputs

Maximum wind the a/c can handle is (b)(7)f

No warnings, advisories, or cautions were active during the descent, given the same conditions during another portion of the flight, they would normally receive warnings.

The a/c was below 200' AGL before he looked at the AO and noticed the look on his face.
He was asked the question a few days after the incident "could it have been prevented", his immediate response was "no" because he was there and from the experience felt there was no time to respond to it. However, after seeing the video and playback of the GCS data, he thought that if they had put it into manual control, they may have been able to straighten out the oscillations.
Asked what recommendations he would propose to fix the problems, he suggested updating the software, improving the BLOS connection, and adding a feed from a video camera on the a/c.

Follow on interview on 10 Jul:
Asked about the standard operating procedures for determining heading on entering a FOB and then determining heading for autonomous cargo drop and relationship to wind. Basic procedures stated were to check the weather before the mission. Verify mission heading via LZ Card and check with FOB. The initial heading to the drop point will be based on the coordinated heading with the LZ and the FOB. The heading for the drop will be based on forecasted winds.

Follow up emails with 1stLt (b)(3) 10 USC 130(b), (b)(6)

From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) VMU-1 FWD CRUAS Mission Commander
Sent: Friday, July 05, 2013 5:22 PM
To: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Subject: RE: A few more questions

Sir,

Answers to your questions:

1) What is the name of the (b)(7)f you were using on 5 Jun?
(b)(7)f

2) What is the name of the JTAC you were in communication with?
1stLt (b)(3) 10 USC 130(b), (b)(6) 2/215 WatchO (b)(7)f

3) Were you in communication with anyone else at (b)(7)f that night, other (b)(7)f if so who and how?
I do not recall communicating with anyone else at (b)(7)f that night. Coordination was done via (b)(7)f (b)(7)f until the mishap occurred and I phoned 1stLt (b)(7)f via (b)(7)f

4) Also, I believe you told me you were limited to (b)(7)f of communication available. Please confirm or correct me if I misunderstood.

You are correct. We are (b)(7)f for communication with the exception of (b)(7)f (b)(7)f used to communicate with (b)(7)f

5) Please tell me again where and when you got the weather for that night and what it said.

I check the weather from a multitude of sources. C-2 Metoc creates a slideshow for CRUAS on Centrix. I, also, have a link to the C-2 warnings & watches page. I look at a METAR from MACS-2 on SIPR. I listen to an ATIS on the (b)(7)f generated by Tower. Finally, we have a local weather station in the tower. My weather brief is compiled from information gathered from all of these sources. The weather sequence from that night was as follows:

Sky conditions: FEW 100 SCT 140
Winds: 280@13kts
Visibility: 7sm
Temp/DP: 38/10
Altimeter: 29.78
Flight Level Winds: 3000 – 285@17kts 6000 - 260@18kts 9000 – 320@18kts

v/r,

(b)(3) 10 USC 130(b), (b)(6)

From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Sent: Friday, July 05, 2013 2:44 PM
To: (b)(3) 10 USC 130(b), (b)(6) RC(SW) VMU-1 FWD CRUAS Mission Commander
Subject: A few more questions

(b)(3) 10 USC 130(b), (b)(6)

I have a couple more questions for you:

1) What is the name of the (b)(7)f you were using on 5 Jun?
2) What is the name of the JTAC you were in communication with?
3) Were you in communication with anyone else at (b)(7)f that night, other than (b)(7)f if so who and how?
4) Also, I believe you told me you (b)(7)f types of communication available. Please confirm or correct me if I misunderstood.
5) Please tell me again where and when you got the weather for that night and what it said.

Thanks,

LtCol (b)(3) 10 USC 130(b), (b)(6)

From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) VMU-1 FWD CRUAS Mission Commander
Sent: Thursday, July 18, 2013 9:09 PM
To: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Subject: RE: More questions

Sir,

Responses to your questions:

The number of flights, hours, and cargo deliveries that (b)(6) and (b)(6) have logged?
(b)(6) 1200 Total Rotary Hours, 78.4 Hours K-Max UAS, 29 Sorties/Deliveries
(b)(6) – 2000 Total Rotary Hours, 83.6 Hours K-Max UAS, 17 Sorties/Deliveries
*Training time at Owego AVO course is calculated into their UAS Flight Hours

1st 0 USC 130(b) numbers:
The numbers you have for me are correct with the exception of the retrograde numbers. That retrograde op was finishing up as I got here so those numbers were on (b)(3) 10 USC 130(b), (previous MC) ticket.

(b)(6) hours:
2039 Total Rotary Hours
11 Hours in K-1200

Cpl 0 USC 130(b) number of loads rigged:
I would concur that over 500 hours is a good estimate for Cpl USC 130(b). He tracks his ASRs (198) but they are often broken into multiple loads. He is a joint air drop inspector, jumpmaster, and HE Operator.

Do you know the total hours on the aircraft? Aircraft 97 shows total 1576.6 hours.
Are the maintenance guys responsible for loading the latest system software on the aircraft? Version #?
System software updates are conducted by the engineer. Current system software version is (3) 10 USC 130

v/r,

1stLt (b)(3) 10 USC 130(b), (b)(6)
CRUAS Mission Commander
VMU-1 (Fwd) "Watchdogs"
2d MAW (Fwd) Camp Leatherneck, AFG
NIPR: (b)(3) 10 USC 130(b), (b)(6)
NIPR: (b)(6)
From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Sent: Thursday, July 18, 2013 10:42 AM

To: [redacted] VMU-1 FWD CRUAS Mission Commander
Subject: More questions

[redacted]

Have a few more questions as I'm writing up the investigation. I pulled some stats from the CRUAS sitrep excel file... I hope I was reading it correctly, would appreciate if you would verify some of the numbers I got out of it.

Do you have documentation on the number of flights, hours, and cargo deliveries that [redacted] and [redacted] have logged? I found your numbers in the CRUAS sitrep... this is what I have for you, if you want to verify what is in the sitrep: "As a mission commander for the CRUAS platform, [redacted] has supervised 104.3 hours of flight time, 78 sorties, the delivery 250,800 lbs of cargo, and the retrograde of 13,050 lbs of cargo." Let me know if that isn't right.

Also anything you have that might document the hours [redacted] has logged would be good too. Just looking for something that shows his experience and would say that he would likely have seen/heard an issue with the aircraft as he was going through the startup procedures if one existed that night.

Anything on [redacted] would be helpful too. He told me that he started with CRUAS in January, so extrapolating from the sitrep, this is what I have: "[redacted] prepared and rigged cargo for the delivery of over 500 cargo loads since his time with the CRUAS detachment."

Do you know the total hours on the aircraft or know where I can get it? I saw it logged about 700 hours in OEF from the sitrep. Also are there any other pertinent stats on the aircraft you think I should include? I have the bureau number and the model number. Are the maintenance guys responsible for loading the latest system software on the aircraft? Wanted to get what version was on there to just to verify it was up to date.

That's it for now... will send more as I come to them.

Thanks for all your help,

LtCol [redacted]

Summary of Email Interview

(b)(6)

Aerial Vehicle Operator

From: (b)(6)
Sent: Saturday, July 06, 2013 4:52 PM
To: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Subject: Re: Questions on CRUAS Mishap

Sir,
Here is my feedback.

Respectfully,
(b)(6)

From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4" (b)(3) 10 USC 130(b), (b)(6)
To: (b)(6)
Sent: Saturday, July 6, 2013 1:22:14 AM
Subject: Questions on CRUAS Mishap

Sir,

I am conducting the JAG Manual investigation for the mishap on the 5th of Jun. I apologize for contacting you on your R&R, but I need a statement from you in order to complete the investigation. I have put a list of questions together in the attached word document. Please complete and return it. In order to complete the investigation on time I will need your answers before the end of the week (12 Jun.)

Please let me know if you have any questions or need any clarifications.

Thank you for your time.

Respectfully,

LtCol (b)(3) 10 USC 130(b), (b)(6)

Attachment contents:

Please state your name and your responsibility on 5 Jun:
(b)(6) AVO

Briefly describe relevant training and experience:
Initial AVO training Owego, NY. In country AVO training, (b)(7)f SUSD training (b)(7)f
Performing AVO duties since Nov 2012.

Jun 5: Please describe the general sequence of events for the mission in question:
Normal sequence of events for 5 Jun. Slept well, ate, gone to work, planned mission, mission brief, verified mission plan with MC, conducted mission.

Anything different or out of the ordinary for that day?
Nothing out of ordinary.

Specific questions related to the events leading up to the mishap:
What did you see? About 500 ft AGL aircraft was pitching plus or minus (b)(7)f degrees.

What did you do? Announced what the aircraft was doing, already identified (b)(7)f with the aircraft.

What communication occurred between the members of the mission team? Verbally confirming what is going on with (b)(7)f with aircraft.

What was communication occurred between the mission commander and other agencies? FOB/DASC/Etc? Requested MC to call the LZ to find out aircraft status. Once the mishap have been identified, MC initiated mishap plan procedures.

When did you first notice something was out of the ordinary? About 500 ft AGL

When did you first realize there was a problem? About 500 ft AGL

What indicated that there may be a problem? Aircraft pitching up and down.

What are the emergency procedures for the problem(s) you noticed? Stop ACDC, give (b)(7)f command to stable aircraft.

What was typical about the mission? A-typical? Everything started normal that day.

Were there any indications earlier in the mission that something might be wrong? None

In your estimation after looking at the data and videos, what do you think happened? Do not know.

Could it have been prevented? If so, how? Yes, (b)(7)f

Do you have any recommendations to prevent a situation like this from happening again? Improve aircraft communication

Is there anything else that you think I should know or questions that I didn't ask? None.

Follow up email with Mr. (b)(6)**:**

From: (b)(6)
Sent: Sunday, July 07, 2013 6:36 PM
To: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4
Subject: Re: Questions on CRUAS Mishap

Sir,

How do you make decisions on the waypoints to use, egress and ingress points, and the heading for auto delivery?

(b)(7)f

cards are use to get in and out of the LZ. Heading for the auto delivery is wind direction dependent after the aircraft weather vane into the wind and stable.

Respectfully,

(b)(6)

From: (b)(3) 10 USC 130(b), (b)(6) RC(SW) 2MAW FWD G-4" (b)(3) 10 USC 130(b), (b)(6)
To: (b)(6)
Sent: Sunday, July 7, 2013 4:38:35 AM
Subject: RE: Questions on CRUAS Mishap

Sir,

I have a couple of follow up questions.

1) When planning the mission is the AVO the primary mission planner? I noted that you said that you "planned mission" and "verified plan with the MC", so assuming that you are the primary mission planer, please answer question 2.

2) How do you make decisions on the waypoints to use, egress and ingress points, and the heading for auto delivery?

Thanks,

LtCol (b)(3) 10 USC 130(b), (b)(6)

Summary of Interview on 1 Jul 13

(b)(6)

Aerial Observer

(b)(6) was the AO on 5 Jun. He is a civilian helicopter pilot, a certified IP, CFI, and CFII, which he defined as being a flight instructor with instrument and commercial rating. He has 1300 hours of manned flight time. Did not have experience with cargo deliver before CRUAS.

On the day of 5 Jun, he outlined the following general sequence of events.

Attended standard preflight brief at 1830

Noted that normally the AVO and AO will switch between flights for the evening, he agreed to be the AO for this flight

Noted there was a tail wind

(b)(7)f

(b)(7)f

(b)(7)f

(b)(7)f

He asked USC 130(b) to call the LZ

The LZ said that the a/c was on the ground

The only anomaly noted during the incident was the pitch

Follow on interview on 10 Jul:

Asked about how the heading is chosen for the auto descent mode:

LZ card gives initial guidance on approach. Predicted weather conditions may cause an adjustment but within the LZ card constraints. At FOB when prepared to descend, while still in a manual hover mode, the aircraft is allowed to weather vane into the wind. Once the controls are centered and the aircraft is stable and the ground is ready to receive the load, then the aircraft is put into the ACDC mode.

Summary of Interview on 1 Jul 13

(b)(6)

Start Up/Shut Down Pilot

(b)(6) was the shutdown/start up pilot for 5 Jun. He is prior military CH-46 pilot with >2k hours. He has been with CRUAS in Afghanistan since April. He is also the assistant site lead.

On the day of 5 Jun, he outlined the following general sequence of events.

- Attended standard brief at 1830
- Started a/c
- Performed functional check flight
- Adjusted rotor turns based on density altitude
- Watched the takeoff from tower @ (b)(7)f
- He was called back to the tower after he went to the office about the issue
- Found out it crashed and executed mishap plan
- Everyone went to medical, he took statements
- Traveled to (b)(7)f for the recovery effort
- Recovery site:
  - Most of the damage was in the tail section
  - Landed in center of (b)(7)f, (b)(3) 10 USC LZ)
  - Cargo was UGRs
  - Blades had disingigrated
  - He removed the laptop from the wreckage with the flight data

Recommendations to prevent future mishaps:

- Staty in contact with the LZ
- Stay in constant contact at (b)(7)f and below
- Improve BLOS speed and connection
- Add camera to see what is happening

Summary of Interview on 2 Jul 13

Cpl [redacted]

Cargo Rigger

Cpl [redacted] is an augment from CLR. His MOS is 0451, parachute rigger, and has been working with CRUAS since January. He has 7 years in the USMC. He was responsible for coordinating with units who have scheduled deliveries, receiving, staging, and preparing the load. He is qualified as a Joint Air Drop Inspector and a Jump Master. His qualifications for rigging loads are validated each month with CLR.

On the day of 5 Jun, he outlined the following general sequence of events.

- 2 Loads of UGRs were rigged the day prior.
- He usually works during the day, coordinating with units and preparing cargo for the flights
- The load prepared for the flight was two warehouse pallets of UGRs
- He used a 5k net that holds 2 pallets, has a 10' inner diameter
- The nets he used were new. He has an issue getting nets back from FOBs, the FOBs tend to use them for many other purposes and they don't get returned.
- CLR has several boxes of new nets, so it is easiest to use new nets for each load.
- Since he works days, he left for the day, before the incident, didn't find out until the next day that there had been a mishap.

Gave a demonstration of setting up a net with load and rigging it to the load hook. Demonstrated where the load must be for balance and showed the second load that was prepared that night but never left after operations halted. Showed how the straps and hooks are overlapped to ensure they stay secure during takeoff, in flight transit, and delivery.

Summary of Email Interview

(b)(6)

Support Engineer

Please state your name and your responsibility on 5 Jun: (b)(6) Engineer on duty

Briefly describe relevant training and experience: I have been working the K-MAX program since 2008, when LM started working with Kaman. I was the lead engineer for the first 2 years of the program, and then supported the program as the engineer assigned to Business Development. Other than a year and a half assigned to another UAV program at Lockheed, I have been working K-MAX engineering since 2008.

Jun 5: Please describe the general sequence of events for the mission in question. The role of the engineer is to encrypt the aircraft LOS Data Link, and to be on call during the mission for equipment anomalies. I encrypted the Data Link prior to flight without any issues.

Anything different or out of the ordinary for that day? Not before the accident. Everything was operating normally.

Specific questions related to the events leading up to the mishap:

What did you see? Prior to the accident, I was not aware of any anomalies. I was not in the COC, as is normal. I was in communication with the COC via (b)(7)f The first indication of a issue was when the AO requested that the engineer and PM come up to the COC.

What did you do? After receiving the radio call, the PM and I went immediately to the COC. After being briefed on the situation, the PM worked with the MC to implement the emergency process, and we secured the COC and all the equipment. I was able to collect a copy of the GCS Logs for analysis.

What communication occurred between the members of the mission team? The PM and I were informed of the situation via radio, and we went out to the COC. The PM instructed the flight crew to go write down there statements, and they were isolated for a period of time.

What was communication occurred between the mission commander and other agencies? FOB/DASC/Etc? The MC we in communication with the FOB via (b)(7)f From whatI understand , the FOB indicated to the MC that the aircraft was down.

When did you first notice something was out of the ordinary? Upon receipt of the radio call for the engineer and PM to come up to the COC.

When did you first realize there was a problem? After arriving at the COC and being briefed by the AVO and AO.

What indicated that there may be a problem? - NA

What are the emergency procedures for the problem(s) you noticed? - NA

What was typical about the mission? A-typical? To my knowledge, there was nothing a-typical about the mission, it was similar to other missions we were conducting at that time.

Were there any indications earlier in the mission that something might be wrong? - NA

In your estimation after looking at the data and videos, what do you think happened? – After review of the data and video, I believe that the load swing started at a point around 700 ft AGL, and became increasingly worse as it descended. The data transmitted to the operators was (b)(7)f and precluded them from seeing what was occurring in time for them to respond.

Could it have been prevented? If so, how? If there was (b)(7 t the time, or if there was someone at the FOB that could relay to the operators of the load oscillation, then the AVO could have arrested the descent and stabilized the load in time to allow a safe delivery.

Do you have any recommendations to prevent a situation like this from happening again? To prevent this from happening again, we need to ensure that the AVO is aware of any load swings that may be developing. This can be accomplished by and of the following:

1) Transmit load angle to the AVO over the data link.
2) (b)(7)f
3) Provide a observer at the delivery site to identify load swings or abnormal descent profiles and report them to the AVO.

Is there anything else that you think I should know or questions that I didn't ask? I am curious how the oscillation initiated. Though this may be a mute point since it was the increase in oscillation that is the root cause of the accident, it would be good to know why the oscillation started in the first place.

Summary of Interview on 1 Jul 13

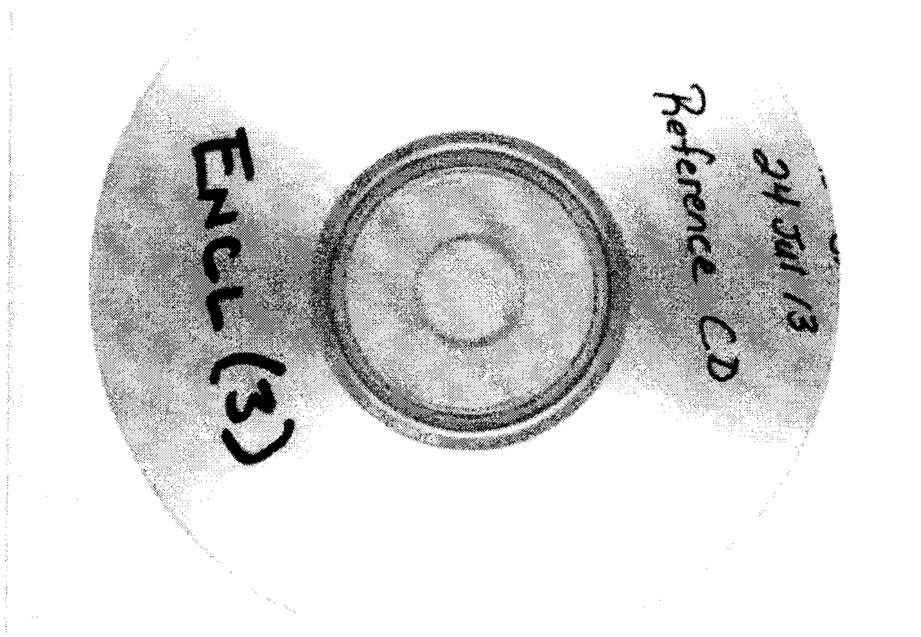
(b)(6)

Aircraft Mechanic

(b)(6) is a mechanic for Swanson and was the mechanic for the a/c involved in the mishap. He has 5 years of USMC experience as a CH-53 mechanic. Noted that the current platform was simpler to work on because of no hydraulics, but had other nuances that still gave it some complexity. He also has 6 months experience as a mechanic on the L3 Vertex Army Helo in Afghanistan. Has been in and out of Afghanistan since Oct 2010 working on different platforms.

On the day of 5 Jun, he outlined the following general sequence of events.

Nothing noted out of the ordinary.
Inspected the a/c inside, outside, looked for vibrations and anything out of the ordinary
No issues with anything
Test flight performed, nothing out of the ordinary, no issues found
He described it as a typical day



ENCLOSURE (3)